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METHODOLOGICAL ISSUES

Methodological issues related to greenhouse gas inventories: Summary of issues and related options

Note by the secretariat

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I. INTRODUCTION

A. Mandate

1. The Subsidiary Body for Scientific and Technological Advice (SBSTA), at its seventh session, requested the secretariat to prepare, for consideration at its ninth session, a document listing methodological issues identified by the secretariat while processing national greenhouse gas (GHG) inventories from Annex I Parties and in the course of in-depth reviews, taking into account the submissions by Parties (FCCC/SBSTA/1997/14, para.16 (c)). The SBSTA, at its eighth session, supported the preparation of a number of documents (FCCC/SBSTA/1998/6, para. 40 (a)), including one on policy options for addressing the identified methodological issues.

2. The SBSTA, at its eighth session, also requested the secretariat to organize a workshop with participation of experts from the roster, as well as from other relevant organizations, to develop proposals to resolve the methodological issues identified by Parties and the secretariat, and to provide the conclusions of such a workshop to the tenth session of the SBSTA (FCCC/SBSTA/1998/6, para. 40 (d)).

3. Also at its eighth session, the SBSTA urged Parties to participate actively in the ongoing activities of the current programme of work on methodologies related to GHG inventories, bearing in mind their relationship with possible additions and/or amendments to the revised guidelines for the preparation of national communications by Annex I Parties[1] (FCCC/CP/1996/15/Add.1, decision 9/CP.2, annex), and the longer-term methodological needs of the Kyoto Protocol, *inter alia*, the development of guidelines for national systems and adjustments under Article 5 of that Protocol (FCCC/SBSTA/1998/6, para. 40 (b)).

B. Scope of the note

4. In response to the above-mentioned mandate, this document identifies methodological issues and proposes policy options for addressing them. A summary of the methodological issues is provided in the annex. The policy options are based on document FCCC/SBSTA/1998/7 and on submissions by Parties. Submissions by Parties on methodological issues are contained in documents FCCC/SBSTA/1998/MISC.2 and FCCC/SBSTA/1998/MISC.6.

5. The options suggested in this note are aimed at improving the degree of completeness, reliability and comparability of the inventory data to ensure that the Conference of the Parties (COP) has sufficient information to carry out its responsibilities to review the implementation of the Convention. Some of the options were developed to take into account possible ways in which inventory data could be used to meet the new requirements derived from the Kyoto Protocol.

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[1] These guidelines are referred to as the UNFCCC guidelines in this note.

6. Documents FCCC/SBSTA/1998/7 and FCCC/SBSTA/1998/8 are intended to be considered at a workshop to be organized by the secretariat from 9 to 11 December 1998, in Bonn.[2] The participants at the workshop will be methodological experts nominated to the UNFCCC roster by governments.[3] The aim of the workshop will be to develop proposals to resolve the methodological issues related to GHG inventories. Relevant parts of the current UNFCCC guidelines will be reviewed and assessed. The secretariat will prepare a report based on the discussions at the workshop. The report will then be made available to a workshop to be organized by the secretariat on guidelines for Annex I communications, and subsequently to the SBSTA. Parties may wish to recall that the secretariat was requested by the SBSTA to organize a workshop on the UNFCCC guidelines. It is currently anticipated that this workshop will be organized in the spring of 1999 with participation of government representatives.

7. In addition, the issues raised in this note are relevant to the preparatory work needed for the first session of the COP serving as the meeting of the Parties to the Kyoto Protocol (COP/MOP). For example, the SBSTA may find the information helpful when it considers guidelines for national systems to account for greenhouse gas emissions by sources and removals by sinks according to Article 5 of the Protocol and the relevant information to be requested according to Article 7 of the Protocol.

8. The IPCC-OECD-IEA Programme on GHG inventories[4] is undertaking a work programme on uncertainties and "good practices", as requested by the SBSTA at its eighth session (FCCC/SBSTA/1998/6, para. 40 (e)). It is also surveying the experience of countries with the Revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories.[5] The secretariat is cooperating with the IPCC Programme in these activities. Once completed, most likely in late 1999, their results will be made available to the SBSTA for further consideration.

9. In view of the ongoing work to address methodological issues related to the estimation and reporting of emissions by sources and removals by sinks from the *land-use change and forestry* sector, this document does not provide information on emissions or removals from this sector.

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[2] The secretariat will also make available at the workshop an informal paper on the comparison of the 1996 GHG inventories submitted by Parties using best available methodologies and those obtained using the current IPCC default methodologies, as requested by the SBSTA at its seventh session (FCCC/SBSTA/1997/14, para. 16 (b))

[3] As at 1 September 1998, 45 Parties had nominated 306 methodological experts for the roster.

[4] The IPCC-OECD-IEA Programme is referred to as the IPCC Programme in this note.

[5] The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories are referred to as the IPCC Guidelines in this note.

C. Possible action by the SBSTA

10. The SBSTA may wish to take note of documents FCCC/SBSTA/1998/7 and FCCC/SBSTA/1998/8, bearing in mind that they will be discussed in detail at a methodological workshop, and provide preliminary comments for consideration by the secretariat.

II. OPTIONS

A. Approach

11. The following options are proffered to facilitate a discussion of methodological issues and/or amendments to the UNFCCC guidelines for the preparation of national communications by Annex I Parties. The options assume that the process for considering revisions to the UNFCCC guidelines is likely to result in amendments to the GHG inventory section, and that any such revisions could be viewed as a transitory step toward methods and reporting requirements for Parties under the Kyoto Protocol.

12. Some of the options, if adopted, could lead to new ways of compiling data. For example, one approach to presenting data in such a transition period could be to compile data over five years as a *simulated* commitment period. Compiling the data in this manner could help Parties to track their performance and might identify problems before the first commitment period under the Protocol. However, compiling data over a five-year period does not preclude presenting the inventory data on a year-by-year basis or comparing data to a single year, such as the year 2000.

13. The options were formulated bearing in mind Parties' experience with the UNFCCC guidelines. The section of these guidelines concerning GHG inventories is detailed. However, it appears that Parties find it difficult to report GHG inventories in a transparent, complete and consistent way. This suggests a possible lack of clarity in the UNFCCC guidelines and/or a lack of conformity in reporting by Parties. It is very difficult to assess the real influence of each of these factors on reporting. To address this problem the secretariat has taken the approach of providing options aimed at eliminating the lack of clarity of the current UNFCCC guidelines.

14. The options presented below are not comprehensive. Other options may exist and could be identified by experts, other relevant organizations and Parties at the workshop mentioned in paragraph 6, above or subsequently by the SBSTA.

15. The differences in the procedures used by, and capacity of, Parties to prepare national GHG inventories were taken into account in formulating the options. For practical reasons related to the management of the data, it is important for options to be relatively simple, while aiding comparability and transparency.

16. In analysing the options, Parties may wish to bear in mind that the issues of flexibility and reporting are closely linked in practice. In some cases this linkage may have a "cause and

effect" nature. In other cases the options for flexibility and reporting complement each other and may be combined in different ways.

17. A list of questions relevant to the analysis of the options provided has been included to facilitate the consideration of such options by experts and Parties. These questions, which are not intended to be exhaustive, precede the presentation of options below.

B. Options related to flexibility

18. ***Options related to the use of different methods/data[6] by Parties[7] (see annex: paras. 1 - 3):*** Is there a best method for each source category that should be used by all Parties? Should standard methods be used in some/all source categories? Could "good practices" be developed and applied in each source category as an alternative, or supplement, to best or standard methods? If so, what are examples of "good practices"?

Options	Description	Implications
(1) Business as usual	All Parties use different methods	Some of the problems identified will persist.
(2) "Best" methods	All Parties use defined "best methods". Some rules should be needed for Parties not using "best methods".	"Best" methods are difficult to define and apply under different national conditions.
(3) "Standard" methods	All Parties use standard methods, possibly simple methods.	Different national conditions are ignored. Quality and accuracy of inventories will be affected. The lowest common denominator may prevail.
(4) Different methods with mandatory application of "good practices"	Parties use different methods, but apply "good practices" to meet a minimum level of quality. Some rules would be needed for Parties not using "good practices".	The application of "good practices" is difficult to verify. It is difficult to define a minimum level of quality for different national conditions.

19. ***Options related to the recalculation of the base year (see annex: paras. 3 - 5):*** Should recalculation of the base year inventories be allowed for a given period of inventory data as a

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[6] The term "methods/data" is used here in a broad sense. It refers to the methods, emission factors and assumptions related to use of the activity data used by Parties for estimating their GHG emissions in different source categories (national procedures).

[7] The use of different methods/data by a given Party over time is covered in paragraph 19 below.

result of improvements in national procedures and data for estimating GHG emissions? If so, do these recalculations require rules?[8] If so, what rules?:

Options	Description	Implications
(1) Business as usual	All Parties recalculate their base year inventories as a consequence of change in methods/data.[9] Some rules are developed to guide Parties.	Identified problems will continue. Quantitative commitments under the Kyoto Protocol will change, because the base year, and therefore the "assigned amounts", will change for methodological reasons. The mix of gases in the aggregated GHG emissions could also change for the same reasons. This will make the comparability of results difficult over time for a given Party.
(2) No recalculations	All Parties use the same methods/data[9] for a determined period for purposes of reporting to the Convention. Emission factors, except for new technologies and activities, are "frozen" for the period.	Incentives to improve the quality of inventories could be reduced, if Parties stop efforts to improve methods. Accuracy of the emission estimates may decrease. Adjustments to inventory data will be needed at the end of a given period.
(3) Limited recalculations	Parties carry out recalculations only for specified cases. Some rules are developed to guide Parties. Limited "freezing" of methods/data.[9]	Implications described in options 1 and 2 will exist, but in a more limited way. There may be a need for adjustments as described in option 2.

C. Options related to reporting

20. ***Options related to the level of detail of the information as a function of the importance of different GHG emissions from various source categories (see annex: paras. 13 - 14):*** Should the supporting information be the same for all source categories or should more detailed information be required for the most significant ones? If more detailed information is required for the most significant source categories, what kind of information should this be?

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[8] These rules could deal with the reasons for and frequency of the recalculations, as well as with the required supporting documentation to be provided.

[9] See footnote 6.

Options	Description	Implications
(1) Non-selective approach	Similar information is provided for all GHG emissions from source categories.	The verification of the data will be more difficult and costly, but more complete as all sources are covered.
(2) Selective approach based on the significance of the emissions	Detailed information is provided for the most important GHG emissions from different source categories (e.g. those representing more than 95 per cent of the aggregated GHG emissions of a given Party). Less detailed information is provided for less significant GHG emissions.	A more cost-effective and manageable verification process could be implemented. It might facilitate a gradual transition to more rigorous national systems under the Kyoto Protocol.

21. ***Options related to the level of detail of the information as a function of years:*** Should the supporting information on inventories be the same for all years? If not, for which years should more detailed information be provided?

Options	Description	Implications
(1) Non-selective approach	Similar information is provided for all years in a given period.	The verification of the data will be more difficult and costly, but more complete as all years are covered.
(2) Selective approach based on the significance of the inventory years	More detailed information is provided for the base year and for the years at the beginning and end of a given period of inventory data. Less detailed information is provided for other annual inventories.	A more cost-effective and manageable verification process could be implemented. It might facilitate a gradual transition to the new conditions set forth in the Kyoto Protocol.

22. ***Options related to the formats for presenting inventory data in a transparent way (see annex: paras. 8 and 10):*** Should completed copies of all or some worksheets used to calculate the inventory be provided by Parties? If so, for what source categories and what level of

aggregation should the worksheets be provided? Should the IPCC standard data tables be[10] provided?

Options	Implications
(1) All worksheets are provided.	Transparency will be enhanced. It will be more difficult to implement owing to the larger amount of data and high cost of data processing.
(2) Worksheets for the carbon dioxide (CO_2) fuel combustion sector using the IPCC reference approach are provided, and the IPCC standard data tables are provided for other sectors	Transparency could be affected in some sectors, but not in the most significant. An easier and less costly approach could be implemented.

23. ***Options related to the comparison of estimates (see annex: para. 9):*** Should this information be provided by Parties? Should comparative information be limited to C_2O fuel combustion emissions, as currently requested by the IPCC Guidelines, or should it be expanded to other source categories?

Options	Implications
(1) No comparative information is provided.	There will be no way to check mistakes and verify data used.
(2) Comparison of CO_2 fuel combustion emissions estimates with those obtained using the IPCC reference approach is provided.	Transparency will be enhanced by facilitating verification and self-verification for the most significant GHG of all Annex I Parties.
(3) Comparative information on GHG emissions from other source categories is provided.	Transparency will be enhanced by facilitating verification and self-verification. This will be more costly and complex depending on the number of source categories to be considered. The feasibility of expanding the approach to other sectors could be assessed.

[10] The 1996 IPCC Guidelines neither request nor provide IPCC standard data tables. Such tables were provided in the previous version of the IPCC Guidelines. The earlier tables could be used for reporting emissions in almost all source categories of the 1996 IPCC Guidelines. Some additional tables would need to be developed for a few source categories, such as *agricultural soils*. The UNFCCC guidelines request the provision of the IPCC standard data tables.

The software developed for estimating GHG emissions following the 1996 IPCC Guidelines [11] may facilitate the provision of comparative information by Parties.

24. ***Options related to supplementary information on methods, emission factors and activity data used for ensuring transparency (see annex: paras. 1, 2, 11 and 12)***: What supplementary information on methods, emission factors and activity data should be provided? What level of disaggregation and/or detail is needed? Should there be an agreed common reporting framework for this information?

Options	Implications
(1) Business as usual	Identified issues will persist. Level of transparency of GHG reporting will vary widely.
(2) A common reporting framework is developed.	There will be a need to standardize reporting formats by sectors, possibly for electronic submissions. Transparency will be enhanced, facilitating verification of estimates. Separate requirements may be needed for those Parties that use CORINAIR[12] for compiling their national inventories.

25. ***Options related to the reporting of CO_2 equivalent emissions (see annex: paras. 3, 4 and 15)***: Should mandatory reporting be required? Should there be a common reporting format? What global warming potentials (GWPs) should be used for a given period of inventory data?

Options	Implications
(1) Business as usual	Non-comparable and inconsistent reporting of these emissions will persist among Parties and over time.
(2) Mandatory reporting with a common format based on decision 2/CP.3 (1995 IPCC GWPs with a 100-year horizon)	Comparability and consistency of reporting of these emissions will be improved. Reporting emissions on a gas-by-gas mass basis, as requested by the current guidelines, should continue.

26. ***Options related to estimating and reporting hydrofluorocarbon (HFC), perfluorocarbon (PFC) and sulphur hexafluoride (SF_6) emissions (see annex: paras. 16 and 17):*** Should the reporting be mandatory? If so, for disaggregated, potential and actual

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[11] The IPCC Programme recently completed software for estimating GHG emissions following methods defined in the 1996 IPCC Guidelines.

[12] CORINAIR is the component dealing with air emission inventories of the European Community CORINE (Coordinated Information System on the State of Natural Resources and the Environment). CORINAIR is also used for reporting to the Convention on Long-range Transboundary Air Pollution (LRTAP) under the auspices of the United Nations Economic Commission for Europe.

emissions? Should actual or potential emissions be included in the aggregated GHG emissions of Parties?[13] How can inconsistent reporting of these gases by most Annex I Parties be improved? Can atmospheric concentrations be used in a systematic way to estimate and verify the amount of emissions from Parties?

Options	Implications
(1) Business as usual	Identified problems will persist, affecting transparency and consistency of reporting.
(2) Mandatory reporting of disaggregated, potential and actual emissions	Transparency will be improved. The Convention will have information for assessing future impacts of these emissions. A common report format may need to be developed.
(3) Mandatory reporting of actual emissions in the aggregated GHG emissions of Parties[13]	Inventory data will be consistent among Parties. Ways of estimating emission reductions will be similar among Parties.

A special assessment of the current national methods for estimating and procedures for reporting of these emissions may be required. This could contribute to a better understanding of these fast growing emissions. Also the feasibility of using atmospheric concentrations of these gases for purposes of verification might be considered.

27. ***Options related to the reporting of bunker emissions (see annex: para. 18):*** Should a common method for estimating *bunker* emissions and a common framework for reporting them be agreed?[14]

Options	Implications
(1) Business as usual	Non-comparable and inconsistent reporting of these emissions will persist.
(2) A common method and reporting framework is followed by all Annex I Parties.	Comparability and consistency of reporting will be improved.

28. ***Options related to the reporting of ozone precursors and sulphur dioxide (SO_2) emissions (see annex: para. 19):*** Should the reporting of these emissions continue under the Convention?

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[13] This option is related to the issue of reporting. Parties need to consider whether actual or potential emission would be the basis for commitment under the Kyoto Protocol.

[14] Parties may also wish to refer to documents FCCC/SBSTA/1996/9/Add.1 and Add.2 which provide additional information on bunker emissions.

Options	Implications
(1) Business as usual	A significant amount of data for gases reported and controlled under other international agreements is provided. This ensures that the UNFCCC has immediate access to data which may be the needed in the future.
(2) No reporting of these gases	Possible delay in gathering information should additional measures for controlling these emissions be considered. Parties and others do not have a single source of information on gases which affect climate change.

29. ***Options related to the special needs of countries with economies in transition (EIT) (see annex: para. 7):*** How can the current problems faced by most EIT countries in preparing and reporting GHG inventories be solved? How can other Parties or organizations help? Are the causes of these problems well identified for all countries?

Options	Implications
(1) Business as usual	It could take considerable time to overcome the identified problems, if each Party deals with them alone.
(2) An assessment of the special needsis carried out	A detailed assessment of each Party's needs could facilitate the solutions and the provision of assistance.

D. Options related to uncertainties

30. ***Options related to uncertainties (see annex: paras. 20 - 24):*** For what purposes will information on uncertainties be used? Should Parties be encouraged to provide additional information on uncertainties? If so, what additional information would be useful? To what level of detail should information on uncertainties be reported? Should methods used to estimate uncertainties be reported?

Option	Description	Implications
(1) Business as usual	No additional information is provided by Parties.	Identified problems and gaps in knowledge will continue until, at least, the IPCC Programme completes its current programme of work.
(2) Provision of optional information on uncertainties by Parties	Parties may be encouraged, to the extent possible, to provide quantitative information on uncertainties of source category emissions on a gas-by-gas basis, on methods used to estimate uncertainties and on estimation of the overall uncertainty associated with each Party's inventory and their change over time.	The additional information provided by individual Parties on these complex issues could be useful for further methodological work and for making decisions. It could also serve as an input to the work of the IPCC Programme.

Annex

SUMMARY OF IDENTIFIED METHODOLOGICAL ISSUES

A. Issues related to flexibility[1]

1. The IPCC Guidelines, developed for a wide range of users, allow Parties great flexibility in estimating their GHG inventories. All 34 Parties whose GHG inventories were analysed by the secretariat declared that they had followed or used the IPCC Guidelines to prepare them, but the approach they used to estimate the inventories varied widely. Parties used either default methods or more advanced methods, either taken from the IPCC Guidelines or from other compatible methodologies. Many Parties used either default emission factors, or emission factors developed on their own, or both in different source categories. Nine Parties used CORINAIR for compiling their GHG inventory and reported using the IPCC reporting format. The diversity of methods and emission factors used by Parties reflects different levels of dissagregation and availability of data when preparing their GHG inventories. Most Parties did not provide specific information on what approaches they used. The IPCC Guidelines have demonstrated their usefulness, enabling Parties to provide inventory data in most source categories and to report the results in a common reporting framework (*paras. 12 - 15/ tables 1 and 2*).[2]

2. Several examples were identified by the secretariat which indicate that the use of different tiers and/or methods, and the use of different emission factors, as well as different ways of gathering activity data or the differences in their quality, could lead to significant differences in emission estimates from sources in a given sector. If these sectoral emissions are large, this could also affect the annual aggregated GHG emission estimates of Parties *(paras.(16 - 23/ tables 4 - 10)*.

3. Changes in GHG emission estimates associated with the use of different global warming potential values over time can be avoided by "fixing" a value of GWP to be used. Decision 2/CP.3 adopted by the COP at its third session reaffirmed the use of the IPCC 1995 GWPs with a 100-year time horizon (FCCC/CP/1997/7/Add.1, decision 2/CP.3, para. 3). A similar provision has not yet been included in the UNFCCC guidelines. The same COP decision (para. 1) stipulates that Parties should use the IPCC Guidelines to estimate and report their emissions. However, because of the characteristics of these Guidelines, this decision does not

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[1] The term "flexibility" is used in this note to refer to the possibility given to Parties to choose different methods, emission factors, and assumptions for estimating GHG emissions, as is allowed and encouraged by the IPCC Guidelines.

[2] The relevant paragraphs and tables of document FCCC/SBSTA/1998/7 summarized in this section are indicated in parentheses at the end of each paragraph. Document FCCC/SBSTA/1998/7 presents the results of the analysis of the inventory data contained in the second national communications and the relevant information from in-depth reviews of national communications

imply that Parties use the same methods for estimating GHG emissions. In fact, Parties have used different methods, all of them compatible with the IPCC Guidelines (*paras. 24 - 34*).

4. Once GWPs have been fixed for a given period of time of inventory data, the only recalculations would be due to changes in methods, emission factors and assumptions, as well as updates in activity data and the new inclusion or exclusion of sources of emissions. These changes, which in this note are referred to as "changes in methods/data", are a consequence of the flexible approach encouraged by the IPCC Guidelines, which is aimed at improving the quality and accuracy of inventories (*paras. 24 - 34*).

5. All Parties which submitted a second national communication had recalculated their base year inventories in relation to estimates provided in the first national communication, except two. These Parties did not present a recalculated figure for their base year in their national communications, despite using updated methods/data for subsequent years. Also, all Parties used different methods/data over time for at least some and, in several cases, many source categories in compiling their inventories. This led to recalculation of the base and subsequent year inventories. In many cases the changes in emission estimates of the base year resulting from these recalculations are significant on a gas-by-gas basis, being generally larger for methane (CH_4) and nitrous oxide (N_2O) than for carbon dioxide (CO_2) emissions. The changes in aggregated GHG emissions in terms of CO_2 equivalent are also significant for many Parties: for 16 of them, these changes exceeded 5 per cent, and for seven of these Parties they exceeded 10 per cent (*paras. 24 - 34/table 11*).

B. Issues related to reporting

6. In general, the quality of the inventory data presented in second national communications was higher than in the first communications, but many problems remain which hamper the reporting of GHG inventories in a transparent, complete and consistent way. The degree of completeness in reporting varies widely. All or almost all Parties reported the most significant individual GHG emissions, such as CO_2 emissions, from *fuel combustion* and *industrial processes*, CH_4 emissions from *enteric fermentation* and *waste* and N_2O emissions from *agricultural soils* and *fuel combustion*. There was little reporting of HFC, PFC and SF_6 emissions, but the number of Parties doing so increased for the year 1995 (*paras. 57 - 59/ table 18*).

7. In general, the reporting by Parties with economies in transition was less complete. The most common problems identified for these Parties are: a low incidence of reporting of HFC, PFC and SF_6 emissions, non-reporting of *bunker* emissions separately from the national totals, a lower level of reporting in the *industrial processes* sector and a lower level of dissagregation of reported emissions by subsectors in the *industrial processes* and *fuel combustion* sectors (*paras. 59 - 60/table 19*).

8. In order to ensure transparency, Parties were requested to provide sufficient information for reconstructing inventories from national activity data, emission factors and other

assumptions. The IPCC standard data tables do not provide the level of detail necessary to reconstruct inventories in all sectors. For this reason the Revised 1996 IPCC Guidelines requested countries to submit the worksheets or equivalent information for all sectors instead of the IPCC standard data tables. The UNFCCC guidelines also request, in addition to the IPCC standard data tables, the provision of worksheets for the *fuel combustion*, *agricultural soils* and *land-use change and forestry* sectors. However, only five Parties submitted worksheets, and in all cases only for the *fuel combustion* sector. It is apparently difficult for Parties to provide the worksheets other than those from the *fuel combustion* sector (*paras. 61 - 63/table 20*).

9. Parties are requested by the IPCC Guidelines to compare *fuel combustion* CO_2 emissions obtained using the IPCC reference approach (tier 1) and their own alternatives, and to explain possible differences. This comparison exercise reveals possible mistakes in the sector responsible for the largest amount of GHG emissions. In the specific case of the fuel combustion sector, the use of a lower tier (tier 1) does not necessarily imply that the results are less exact or that big differences exist with those obtained using more advanced methods, as was demonstrated by the six Parties which provided this comparison (*paras.17 - 19 and 64/ tables 3 and 20*).

10. Only 18 Parties provided the IPCC standard data tables. The UNFCCC guidelines request that Parties provide these tables. Although they do not provide the level of detail necessary to reconstruct an inventory, they provide information on the aggregated activity data and emission factors used. They serve the purpose of comparing among countries and checking transparency and completeness. Undoubtedly, the 18 Parties which provided these tables presented a more transparent inventory than those which did not (*paras. 61 - 65/table 20*).

11. Most Parties did not specifically indicate which IPCC tier or national methods were used to estimate their emissions. In general the documentation on emission factors provided by Parties is poor. Many Parties did not provide any numerical values for the emission factors and many others only provided aggregated emission factors through the IPCC standard data tables. Few Parties presented more dissagregated information, identifying values of specific emission factors which were applied in key sectors (*paras. 68 - 70/tables 1, 2 and 21*).

12. Supporting documents with detailed data on activity statistics, emission factors and methods used could potentially lead to more consistent and transparent inventories. The UNFCCC guidelines request this background documentation without a clear definition of the specific information to be provided. Some Parties provided this background documentation, but its quality varies widely and in general does not allow the emission estimates to be reconstructed, even in the most important sectors. Most Parties only provided a brief documentation or did not provide it at all. A clear definition of what documentation should be provided is necessary, because the characteristics and magnitude of the GHG inventory data are such that it is virtually impossible to provide all the background data (*para. 71*).

13. In each country, GHG emissions within only a small number of specific source categories are responsible for the bulk of aggregated GHG emissions. It should be borne in mind

that a source category may have emissions of different GHGs (eg. CO_2, CH_4 and N_2O), but only one of them may be significant and the others negligible. The current IPCC sectors and subsectors have at least 60 particular GHG emissions from source categories for which emission factors and activity data are required to estimate emissions. Given that for all Parties a limited number of particular GHG emissions are responsible for the majority of their emissions, emphasis could be placed on giving detailed information on only these emissions for each Party. For most Parties, CO_2 from *fuel combustion* and *industrial processes* , CH_4 from *enteric fermentation* and *solid waste* and N_2O from *agricultural soils* and *fuel combustion* (mainly transport) are among the top individual GHG sources (*paras. 72 - 76/tables 22 and 24*).

14. When estimating emissions on a gas-by-gas basis each GHG in each source category requires specific emission factors. In practice, the particular GHG emission estimates from source categories act as individual "blocks" in "building" the inventory. The most important or "top" particular GHG emissions from different source categories are different for each Party. They are different for individual Parties because of the differentiated structure of their economies. For 90 per cent of the reporting Parties, 30 out of 34, more than 90 per cent of their aggregated GHG emissions is attributable to their five top particular GHG emissions, more than 94 per cent is attributable to their seven top GHG particular emissions and more than 96 per cent of their emissions is accounted for by their 10 top particular GHG emissions from different source categories (*paras. 72 - 74/tables 22 and 23*).

15. Twenty-seven parties reported their emissions in terms of CO_2 equivalents. The reporting of GHG emissions in terms of CO_2 equivalent is not required by the IPCC Guidelines and is optional under the UNFCCC guidelines. The latter do not provide guidance on whether the GHG emissions expressed in CO_2 equivalent should be provided at a sectoral or at a national level or on the format (e.g. tables) to present the data. The reporting of CO_2 equivalent emissions should not affect reporting on a gas-by-gas basis using mass units which is essential for purposes of transparency, as requested by the UNFCCC guidelines (*para. 67/table 20*).

16. Reporting emissions of HFCs, PFCs and SF_6 on a mandatory basis is a new requirement of the UNFCCC guidelines and was included for the first time in the Revised 1996 IPCC Guidelines. Only 21 Parties provided data on these emissions, and not all of them reported emissions of all three gases. The quality of the data provided by the 21 Parties varies widely, and in general the data are incomplete. Some Parties only reported aggregated figures for HFCs and PFCs, which affects the accuracy and transparency of their reporting. Seven Parties which reported HFC emissions used an actual approach, and three of them also reported estimates using a potential approach. The other Parties used only a potential approach or it was not clear what approach was used. The reporting of PFCs and SF_6 contained similar problems. Two Parties reported gases with high GWPs, such as nitrogen trifluoride (NF_3), for which the IPCC has not yet estimated GWP values (*paras. 77 - 79/table 25*).

17. Decision 2/CP.3 affirms that actual emissions of these gases should be used for the reporting of HFC, PFC and SF_6 emissions. The SBSTA, at its fourth session, encouraged Parties to report both actual and potential emissions (FCCC/SBSTA/1996/20, para. 31).

a given Party. One Party indicated the usefulness of examining atmospheric concentrations of these gases as background information to assess the real leakage rates (actual emissions) from equipment containing them (*paras. 77 - 81/table 25*).

18. *Bunker* emissions were reported separately from *fuel combustion* emissions by 27 Parties as requested by the IPCC and the UNFCCC guidelines. Seven Parties, all EITs, did not provide this information, owing to difficulties in gathering this information in their national statistics. The share of *bunker* emissions in total GHG emissions of reporting Parties ranged from 0.1 (United States of America) to 19 per cent (the Netherlands). Fourteen out of the 27 Parties which reported these emissions separated them into *marine* and *aviation bunkers* in their national communications or supporting materials. This separation is requested by the UNFCCC guidelines and COP decision 2/CP.3. The method used to estimate *bunker emissions* is also not consistent among Parties.[3] Most Parties did not specify what methods they used. For 13 out of 15 Parties which in addition to CO_2 also reported CH_4 and N_2O emissions, the share of CO_2 emissions in the aggregated GHG *bunker* emissions is higher than 98 per cent (*paras. 82 - 84/table 26*).

19. All reporting Parties except two reported emissions of nitrogen oxides (NO_x), carbon monoxide (CO) and non-methane volatile organic compounds (NMVOC), as requested by the IPCC and UNFCCC guidelines. Sixteen Parties optionally reported sulphur dioxide (SO_2) emissions which is encouraged by the revised versions of both guidelines. These gases influence global warming rates, but the calculation of specific GWPs for them is not currently possible. It should be noted that almost all Annex I Parties are Parties to the Convention on Long-range Transboundary Air Pollution. Parties under that convention and its protocols systematically report the emissions of these gases and have programmes for their reduction (*para. 66/table 20*).

C. Issues related to uncertainties

20. In general, the proportion of each greenhouse gas (CO_2, CH_4, N_2O, HFCs, PFCs and SF_6)[4] within the aggregated GHG emissions of each Party, in other words, the mix of gases, changed little for most Parties within the period 1991-1995, compared to 1990.[5] The information available suggests that the mix of gases is a very important element in determining the overall level of uncertainty associated with a given GHG inventory. For example, a change which resulted in an increased share in the mix of gases of a given GHG that is believed to have a low confidence level, could increase the level of uncertainty associated with the inventory (*paras. 36 - 39 and para. 56/tables 12 and 17*).

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[3] Parties may also wish to refer to documents FCCC/SBSTA/1996/9/Add.1 and Add.2 which provide additional information on bunker emissions.

[4] HFC, PFC and SF_6 emissions were considered together in the analysis.

[5] This period could be viewed as a *simulated* "commitment period" under the Kyoto Protocol with the purpose of managing inventory data over time. Information on the effect of aggregating annual GHG emission estimates for a given period of time can be found in document FCCC/TP/1997/2.

resulted in an increased share in the mix of gases of a given GHG that is believed to have a low confidence level, could increase the level of uncertainty associated with the inventory (*paras. 36 -39 and para. 56/tables 12 and 17*).

21. The consistent set of 1990-1995 data facilitates preliminary insights into the extent to which changes in CO_2 equivalent emission estimates over time are due to socio-economic driving factors or to changes in calculation procedures. The data reveal that changes in GHG estimates due to changes in methods/data were more relevant than changes due to socio-economic driving factors for 13 Parties. In other words, emission estimates for the base year and for the years included in a commitment period can change as a result of methodological considerations. As Parties apply new methods/data for all years, the effect of these changes is not obvious, simply from the data provided in the last submitted inventories. Only some Parties provided detailed information about changes made to estimates provided in previous inventories (*paras. 36 - 39/table 13*).

22. The information provided in national communications indicates that the approaches to estimating and reporting uncertainties vary widely among countries. Therefore, the information is not comparable. Twelve Parties did not provide estimates of uncertainties, and only 13 Parties provided quantitative estimates of uncertainties on a gas and/or sectoral basis. Other Parties provided the IPCC overview table, which includes a qualitative assessment of the estimates (*paras. 40 - 42/table 14*).

23. Using a simplified approach[6] to estimate the uncertainty associated with a GHG inventory, it was observed that the changes in this uncertainty over time are considerably less than its absolute level in any particular year for all Parties. It was also detected that a Party's changes in methods/data may influence the approximated level of uncertainty associated with the GHG inventory in any single year, as well as the changes in the level of uncertainty over time. The implications of this influence require further assessment (*paras. 41 - 56/tables 15-17*).

24. There is a clear need for technical and scientific work to develop comparable approaches to estimating and reporting uncertainty in GHG emission estimates. It would be desirable to have such work guided by the anticipated uses of such information by Parties. The estimation of the overall uncertainty associated with GHG inventories, and the assessment of changes over time, also require such work, particularly since the adoption of the Kyoto Protocol. The IPCC Guidelines do not provide guidance on how to estimate uncertainties over time, nor do the IPCC or UNFCCC guidelines request this information from Parties (*paras. 40 - 56*).

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[6] A detailed description of the approach used is provided in FCCC/SBSTA/1998/7, paragraphs 44 - 53 and tables 15 and 16. Similar results were obtained using sectoral uncertainty factors provided by some Parties, instead of the general uncertainty factors by gas used in the approach mentioned before (see paragraph 56 and table 17 of the same document).